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Problem solving patterns in design science research - Learning from engineering

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ONLINE, SET, GO - DESIGN AND EMPIRICAL TEST OF AN IT-BASED PHYSICAL ACTIVITY INTERVENTION

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Abstract

Inactivity is the most widespread health risk factor in modern societies today, causing not only individual health problems but also immense costs for the healthcare systems. This emphasizes the need for improving population-wide impact of activity interventions, with particular attention to cost-effectiveness, scalability, and delivery channels. In this paper, we present the theory-motivated design (drawing on the transtheoretical model) and empirical test of an IT-based physical activity programme (Personal Health Manager, PHM). In order to be as cost-effective as possible, the PHM was designed to have only few face-to-face contacts and to deliver supervision through the internet.

Our design and implementation proved to be successful in a pilot test with 88 employees of an automotive company. The PHM increased participants' activity, motivational readiness for change, functional capacity and transported the feeling of being well taken care of. Enhanced supervision did not increase performance. The results are first evidence that internet-mediated supervision can be successful in promoting physical activity and provide a starting point for investigating the role of face-to-face-contact and service levels in physical activity programs. The PHM and similar designs are also relevant to practice as the semi-automation makes them eligible for large-scale corporate or public health programs.

Keywords: telemedicine, behaviour change, user participation, action research

1 INTRODUCTION

Physical activity and exercise are widely recognized today as key factors in maintaining and restoring health (Wagner & Brehm 2008). Many health problems and diseases are associated with certain habits, among them lack of physical activity. For the US, it is estimated that about 12% of yearly deaths can be ascribed to lack of regular physical activity (Pate et al. 1995b). Furthermore, it is assumed that about one quarter of the population of the western industrial nations are suffering from metabolic syndrome (Whaley et al. 1999). The metabolic syndrome as a term for the simultaneous occurrence of multiple risk factors (all linked to physical inactivity) is presumed to be a warning signal for the development of coronary heart diseases. However, only about 10 to 20 percent of the adult population in western industrial nations can be described as active enough to achieve health protecting effects. Inactivity therefore is the most widespread risk factor in the population, causing not only individual health problems but also immense costs for the healthcare systems (Wagner & Brehm 2008).

The prevalence of inactivity and its economic consequences emphasize the need for improving population-wide impact of activity interventions, with particular attention to cost-effectiveness, scalability, and delivery channels. As a conclusion of a review of physical activity interventions, Eakin (Eakin 2000) points out the need for research on non-physician delivery of activity intervention and on cost-effective ways of activity consulting and the conduction of follow-ups. In a recent review, Marcus et al. (2006) confirm and detail these research demands: "Further research should pursue better understanding of the minimal amount of face-to-face contact necessary for behaviour change and related cost-effectiveness issues. Questions concerning the most effective channel or combination of channels (e.g. print, telephone, or internet) for intervention delivery must be answered […]". The development or internet- and IT-based programmes seems even more appropriate as the diffusion of internet access across all social classes and ages has been rising constantly over the past years (Statistisches Bundesamt 2008).

This research takes up these issues from an information systems point of view. Drawing on the transtheoretical model, we designed an IT-based physical activity programme for currently inactive people, combining both automatic and face-to-face services. The programme was implemented and tested in a three month pilot test in cooperation with the health promotion department of a German automotive company. In this article, we will focus on the participants' side and perception of the programme. Key questions are if a physical activity intervention with supervision mainly delivered through internet-mediated channels is effective in increasing physical activity behavior, and if participants perceive this supervision as appropriate and satisfying.

2 THEORETICAL BACKGROUND: THE TRANSTHEORETICAL MODEL APPLIED TO PHYSICAL ACTIVITY

The transtheoretical model (TTM) is an integrative framework for understanding how individuals progress toward adopting and maintaining health behaviour change (Prochaska et al. 1998). The TTM uses stages of change to integrate processes and principles from various theories of intervention and psychotherapy, hence the name "transtheoretical". Originally developed in the context of addictive behaviour, it has been widely applied to physical activity (e.g. Marcus & Forsyth 2003, Marcus et al. 1998b, Marcus et al. 2000, Velicer et al. 2006, Prochaska et al. 2008, Sarkin et al. 2001).

The TTM describes intentional behaviour change as a temporal process that unfolds through a series of five sequential stages. Progress through the stages is impacted by 10 processes of change. Other constructs affecting progress through the stages are the decisional balance, reflecting the individual's relative weighting of pros and cons of changing, as well as self-efficacy, reflecting the situation-specific confidence in practicing the new behaviour as intended (Prochaska & Velicer 1997).

2.1 Stages of Change

The stage construct represents a temporal dimension, a characteristic that sets it apart from any other construct used in many social-cognitive theories. According to DiClemente et al. (DiClemente et al. 1991), the construct is in between temporally stable personality traits and dynamically changing personality states – the stages can thus be both stable and dynamic. The original concept assumed a unidirectional progress through the stages. This has been replaced by a cyclical or spiral approach: The stages can be passed through repeatedly, allowing for both remaining on a certain stage as well as relapsing to a prior stage (Prochaska et al. 1992).

The following paragraph describes the five stages of change (Keller et al. 1999) and their adaption to physical activity (Marcus et al. 1992).

1) Precontemplation: Individuals in precontemplation have no intention to change. This can be due to ignorance about the consequences of their current behaviour, but can also be a consequence of resignation after having failed to change repeatedly. For physical activity: Individuals do no physical activity and do not intend to start in the next six months („not thinking about change“).
2) Contemplation: Individuals in contemplation intend to change. They think about a certain behaviour and weigh pros and cons. Ambivalences arise. For physical activity: Individuals do no physical activity but intend to start in the next six months („thinking about change“).
3) Preparation: Individuals in preparation have decided to change. They have designed an action plan and have taken first steps to change. For physical activity: Individuals do some physical activity but not at levels meeting the recommended level[1] („doing some physical activity“) and they may or may not intend to become more physically active.
4) Action: Individuals in action have been practicing the new behaviour for a short time (up to six months). The risk for relapses is especially high on this stage. For physical activity: Individuals participate in recommended amounts of physical activity but have done so for less than six months and may or may not maintain this level of physical activity („doing enough physical activity“).
5) Maintenance: Individuals in maintenance have been practicing the new behaviour for more than six months and have reached a relative stability. The risk for relapses decreases. For physical activity: Individuals have participated in recommended amounts of physical activity for six months or longer („making physical activity a habit“).

2.2 Processes of change

The processes of change are covert or overt activities that people use to progress through the stages. Prochaska et al. have identified ten processes of change reflecting two main categories: cognitive and behavioural processes (Prochaska et al. 1988). For many behaviours, cognitive processes seem to be especially relevant in early stages (contemplation, preparation), whereas behavioral processes are mainly applied in later stages (action, maintenance) (Prochaska et al. 1994). Specifically for exercise behaviour, Marcus, Rossi, Selby et al. (Marcus et al. 1992) have identified the cognitive and behavioral processes displayed in Table 1. The question if some processes of change are of more or less importance on different stages of change in exercise behaviour has not been answered yet

[1] Marcus & Rossi refer to the following guidelines: Centers for Disease Control und Prevention (CDC)/ American College of Sports Medicine (ASCM) Pate, R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G. W. and King, A. C. (1995a). Physical activity and public health. A recommendation from the centers for disease control and prevention and the american college of sports medicine. *Journal of the American Medical Association* 273 (5), : Accumulating at least 30 min of moderate physical activity on at least five days a week. ASCM American College of Sports Medicine (1990). American college of sports medicine position stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. *Medicine and Science in Sports and Exercise* 22 (2), 265-274.: At least 20 min of continuous vigorous activity on at least three days a week.

(Pahmeier 2008). Comparative analyses indicate that both cognitive and behavioral processes are relevant in all stages (Marcus et al. 1992), being applied more often the higher the stage is (Marshall & Biddle 2001).

Cognitive processes	Behavioural processes
Increasing knowledge	Substituting alternatives
Being aware of risks	Enlisting social support
Caring about consequences to others	Rewarding yourself
Comprehending benefits	Commiting yourself
Increasing healthy opportunities	Reminding yourself

Table 1: Processes of change in exercise behaviour (Marcus et al. 1992)

2.3 Further constructs in TTM: self-efficacy and decisional balance

Self-efficacy (Bandura 1997) is the individual situation-specific confidence a person has that he or she can cope with high-risk situations without relapsing to their unhealthy behaviour. For exercise, it reflects the confidence in doing physical activity even if confronted with certain barriers. Self-efficacy is assumed to be lower in early stages than in higher stages (Lippke & Plotnikoff 2006), (Marshall & Biddle 2001).

The decisional balance reflects the individual's relative weighing or the pros and cons of changing. The perceived pros increase in the first three stages and then remain on an almost equally high level throughout the last two stages. In contrast, the cons decrease throughout the last three stages (Keller et al. 1999), (Marshall & Biddle 2001).

2.4 Implications for the design of the Personal Health Manager

We use the theoretical foundations of the TTM for designing the PHM following a theory-based design approach (Briggs 2006, Leimeister et al. 2009a).Following the TTM, interventions must be adapted to the specific stages of change the targeted persons are in (Loughlan & Mutrie 1997). Helping people to progress one stage in the course of the program seems a reasonable goal (Prochaska et al. 1998). Past research suggests that movement from the early to the more advanced stages of motivational readiness for physical activity adoption is also significantly associated with changes in functional capacity (maximum oxygen uptake, VO2 max) (Marcus et al. 1998a).

In the case of the PHM, we target people engaging in physical activity less than once a week or not at all. According to the definitions above, those people would be in the early stages of change, namely precontemplation, contemplation and preparation (I1). Processes of change act as independent variables that people need to apply to move from stage to stage (Prochaska et al. 1998). They therefore provide important guides for interventions for every stage that should be addressed in the design of the PHM (I1.1). Self-efficacy in our targeted stages is still low, and should be increased (I1.3). The communication in these stages should emphasize the pros of physical activity (I1.4). Another effective way of adapting interventions to participants apart from targeting them according to a certain variable (e.g. stage of change), is tailoring them to the individual. A combination of both approaches has been found to increase physical activity (Marcus & Forsyth 2003) and should be addressed in the PHM (I2). Figure 1 shows an overview of the described relationships. All implications are presented in Table 2.

I1. The PHM should target people in the stages of precontemplation, contemplation and preparation.
1.1. The PHM should increase cognitive processes of change.
1.2. The PHM should increase behavioral processes of change.
1.3. The PHM should increase self-efficacy.
1.4. The PHM should emphasize the pros of physical activity.

I2. The PHM should offer tailored elements.

Table 2: PHM design implications from TTM (own illustration)

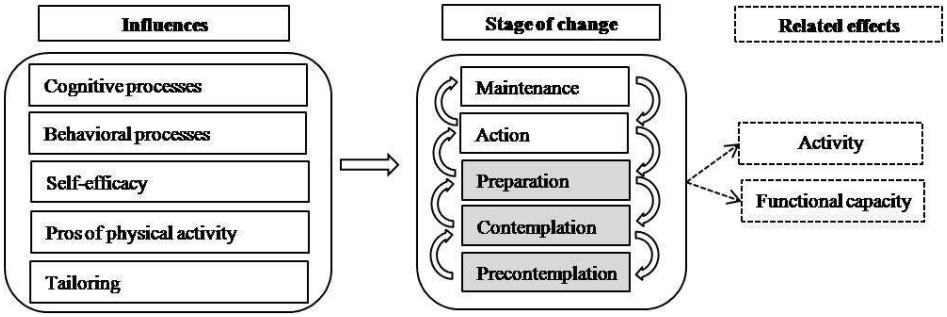

Figure 1: Visualization of influences, stages of change and related effects underlying this paper (own illustration)

3 DESIGN OF THE PHM

3.1 Procedure

As most physical activity interventions, the PHM program will be subdivided into a start phase (SP), an activity phase (AP) and an end phase (EP). The start and end phase consist of mainly singular activities, such as informing the participants on the procedure of the intervention or the end of the intervention, training them on the topic or collecting evaluation data. The collection of evaluation data (e.g. medical data) mostly requires face-to-face contact. We will therefore design most activities of the start and end phase as face-to-face contacts.

In our opinion, the most interesting phase for testing alternative delivery channels is the activity phase. We have two reasons for this: First, supervision in the activity phase is very time and resource-consuming. Supervision of the participant in the activity phase requires the supervisor to perform mainly repeated activities, such as checking the participant's performance, giving feedback, answering questions, motivating and reminding over a longer period of time. Second, supervision in the activity phase is very important to help participants stick to physical activity. Partial automation or IT-support for supervising processes and their delivery through the internet or other media therefore hold great potentials for reducing cost and increasing the scalability of activity interventions.

As a preparation for the design, we first analyzed and documented the basic supervision activities delivered in offline physical activity programs. We then identified potentials for automation or IT-support in these activities using a four step approach assessing priority (frequent, time- and cost-intensive activities with high possible savings are considered first), quality standard and customer experience (customer still should perceive individual supervision), technical feasibility, and required parties in the activity (for instance, registration for the PHM could be performed by the participant interacting with a system in absence of a supervisor). With this background information, we started designing elements of the physical activity programme to meet the requirements derived from TTM. The design was done in multiple iterative steps, and was reviewed and refined by an interdisciplinary team with backgrounds in information systems, sports medicine, business and communication (Knebel et al. 2007). A prior, much simpler prototype had previously delivered promising results in field tests (Leimeister et al. 2009b). The following sections provide an overview of the design elements addressing the requirements from TTM.

3.2 Addressing precontemplation, contemplation and preparation (I1)

In the early stages, people usually have little knowledge or experience with physical activity. The content of all information should therefore be basic knowledge about physical activity presented in a simple way (D1). How this content should be communicated is detailed in the following sections.

3.3 Addressing processes of change, self-efficacy and pros of physical activity (I1.1-I2)

For physical activity, all of the processes are important in all of the stages of change (see section 2.2). However, it is hardly feasible to emphasize all processes at each contact with the individual, and thus key processes are usually selected based on a person's stage (Marcus et al. 1998a). In our design, we focused on the cognitive processes and on 4 of the behavioural processes. Some elements seem appropriate to address more than one process, or address self-efficacy and the pros of physical activity as well. Table 3 shows the variables from TTM (implications from 2.4; I1.1-I2) and the PHM design elements addressing them (DI.1- D2).

TTM Implications (I)	PHM Design element (D)
D1.1: Support cognitive processes (I1.1)	
Increasing knowledge	• training unit (importance of physical activity, advice on how to become active) (SP) • print information on how much and which activities to do (SP) • training unit (how to use PHM online system) (SP) • online exercise plan with instructions (AP) • e-Mail information on diet and exercise (2 per week) (AP)
Being aware of risks	• training unit (risk factors for metabolic syndrome) (SP) • print information on metabolic syndrome (SP)
Caring about consequences to others	(implicit)
Comprehending benefits	• training unit (benefits for physical and psychological health) (SP) • physical fitness test (oxygen uptake) before and after the program (SP, EP)
Increasing healthy opportunities	• training unit (everyday activity as taking stairs etc) (SP) • time- and place-independent access to online system (AP) • flexibility (individual exercise at home possible, choice from a variety of endurance sports possible) (AP) • organize inexpensive, time-limited test membership in corporate gym (AP)
D1.2: Support behavioural processes (I1.2)	
Substituting alternatives	(not addressed)
Enlisting social support	• training lecture organized in groups (SP) • invitation to participation sent out by employer (SP) • individual support by trainers possible (mail, phone) (AP)
Rewarding yourself	(not addressed)
Commiting yourself	• online documentation of activity (AP) • online exercise plan with instructions (AP) • weekly activity goal (AP)
Reminding yourself	• online exercise plan displayed as calendar (AP) • documented exercise units displayed in calendar (AP) • colour-coding for planned, completed, cancelled and missed exercise units (AP)
D1.3: Support self-efficacy (I1.3)	
	• encourage people in all personal meetings (SP, EP, AP)
D1.4: Emphasize the pros of physical activity (I1.4)	

	• training unit, personal and e-mail communication present positive aspects of physical activity (SP, EP, AP)

Table 3: Design elements addressing processes of change, self-efficacy and pros. SP=start phase; AP=activity phase; EP=end phase (own illustration)

3.4 Addressing the tailoring of the intervention (I2)

In addition to the stage-targeted design elements presented in the previous section, we integrated elements that provide individually tailored feedback based on the participants' input (Table 4).

Requirement	PHM design element
D2: Tailoring of the intervention (I2)	
	• system calculates individually recommendable heart frequency for exercise (AP) • systems checks goal achievement and adjusts or retains exercise plan (AP) • trainer checks documentation and contacts participants actively every month (AP) • individual supervisor feedback based on exercise documentation (monthly) (AP) • message system in PHM system to contact trainer (AP)

Table 4: Design elements addressing the tailoring of the PHM . SP=start phase; AP=activity phase; EP=end phase (own illustration)

3.5 Schedule

Start phase: Participants start the PHM activity program with a 90 min training, covering importance of physical activity, benefits, risks and advice on how to become more active, as well as how to use the PHM internet platform. The training is accompanied by print information material. All participants take a fitness test.

Activity phase: After the fitness test, the participants get access to an online exercise plan containing endurance and strength units. The plan contains instructions and also a documentation tool. To reach the weekly activity goal, participants must have performed and documented all planned exercise units. They perform their exercise following the plan autonomously, using a heart rate monitor to check the intensity. Exercise can take place at home, outdoors, or at the gym. In specific situations the participants are contacted by a supervisor: First, in a monthly phone call, second, if the supervisor notices major irregularities in the participant's activity documentation (for example not reaching the weekly goal multiple times, documentation about not being satisfied etc), or third, if the participant himself actively requests information. This enables the supervisor to interfere where it is most necessary and motivate potential dropouts to continue with their activity. E-Mail information on exercise and diet are sent out to all participants twice a week.

End phase: At the end of the programme, the participants repeat the fitness test and take part in a closing event.

4 PILOT TEST

4.1 Evaluation goals

We have two major evaluation goals. First, to evaluate the overall effectiveness of our design. This will be answered by comparing the output variables described in Figure 1 (motivational readiness, activity level, functional capacity) before and after the program. We will also consider the subjective

impressions of the participants concerning the semi-automatic nature of the PHM. Second, we aim to evaluate the effectiveness of those design elements supporting active supervision in the activity phase. This will be answered by comparing two test groups, one receiving active supervision in the activity phase (premium group), and one not receiving active supervision in the activity phase (basic group).

Our data collection is therefore guided by the following research questions:

- Do the PHM participants progress in their motivational readiness for change? Is this effect stronger for the premium group?
- Are the PHM participants more active? Is this effect stronger for the premium group?
- Does the functional capacity of the PHM participants increase? Is this effect stronger for the premium group?
- Do the participants feel positive about the PHM? Is this effect stronger for the premium group?

4.2 Test setting

The pilot test was conducted in cooperation with the worksite health promotion of a major German automotive company. To make participation as easy as possible for the employees, all fitness tests and all administrative issues took place at the corporate gym, the initial trainings and closing events at a university site at a small distance from one of the major company buildings. The elements of the program were implemented as described in the schedule in the previous section (total duration: 4 months, April-July 2008). The participants were randomized into two groups. The basic group received all designed services in the start and end phase, but only passive support in the activity phase (e.g. by providing them with an activity documentation tool). The premium group received all the services the basic group received and in addition to that active support in the activity phase (Figure 2).

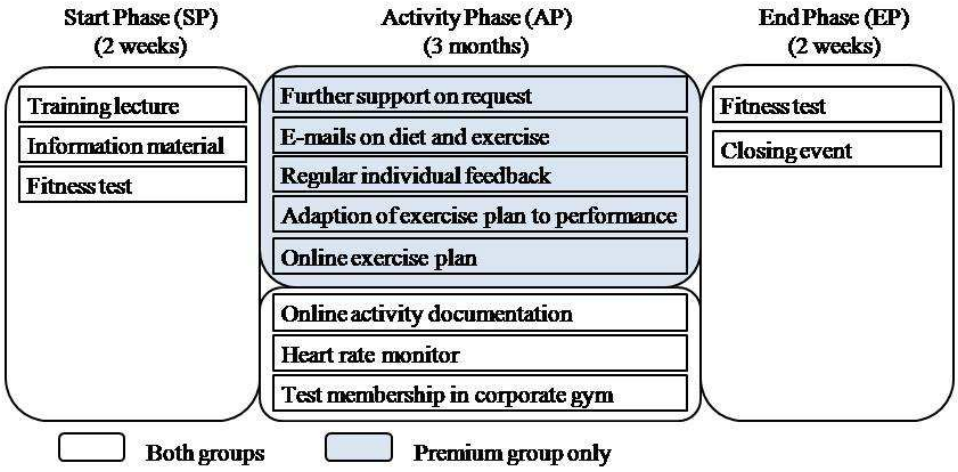

Figure 2: PHM implementation for basic and premium test group

4.3 Data collection and measures

Motivational readiness for physical activity adoption was assessed using the five-item motivational stage measure for physical activity by Marcus & Rossi (1992) both at the beginning and at the end of the PHM programme. To capture *functional capacity*, we measured the maximum oxygen uptake (VO2 max) in the fitness tests at the beginning and the end of the program, on the same day as or very few days from the stage measure.

Physical activity level at the beginning and the end of the program was assessed using a self-report physical activity questionnaire (Freiburg questionnaire of physical activity, Frey et al. 1999), subdivided in everyday activity, sport activity and total activity. People reaching a total score of min. 30 points or min. 14 sport activity points are classified as doing enough physical activity, a total score of 15-29 as fulfilling the minimum, and below as being inactive.

Perception of the PHM was assessed by single items on a 5-point scale at the end of the program. Items included statements to evaluate if participants felt healthier, gained knowledge and liked using the PHM system.

4.4 Participants

We decided on an active recruitment approach, which has proved to be more successful than reactive approaches in other health promotion contexts (Prochaska et al. 1998). 140 inactive, overweight men and women with 2 or more metabolic syndrome risk factors were recruited through an in-house mailing sent by the worksite health promotion department and randomized into the basic (BG, n=55) and the premium group (PG, n=85). 107 took the fitness test in the start phase, 88 completed all questionnaires (baseline and 3 month questionnaire) in the pilot test (n basic group (nb)=33, n premium group (np)=55). Their age ranged from 25 to 60, averaging at 45.4 years. The remainder of this paper focuses on the participants who completed both questionnaires.

5 RESULTS

Motivational readiness for change: As expected, the vast majority of participants in both groups was in precontemplation, contemplation or preparation at baseline (PG: 78.2%, BG: 97.0%), 21.8 % of the PG and 3% of the BG surprisingly already on a higher stage. After three months, 65.5 % of the PG and 81.9% of the BG had progressed at least one stage. At the end of the programme, 72.4 % of the PG and 81.8 % of the BG had reached at least the action stage, meaning they were physically active on a regular basis (Table 5). These results indicate a very positive effect of the PHM, but must be interpreted with caution. According to the definition of the stages, a progress from preparation to maintenance (active for more than six months) is not possible within three months. Apparently, some participants did not understand or not answer the questions correctly. The average overall *functional capacity* (VO2 max) increased (p=0.03; np=46, nb=26), the difference between PG (+ 4.4%) and BG (+2.8%) was not significant (p=0.66).

Stage of change	**Premium group**		**Basic group**	
	Base -line	**3 months**	**Base-line**	**3 months**
Precontemplation	1	2	0	0
Contemplation	21	6	15	4
Preparation	21	7	17	2
Action	3	20	1	16
Maintenance	9	20	0	11

Progress	**3 months**	
	Premium group	**Basic group**
negative	8	0
Unchanged	11	6
+1	15	9
+2	14	15
+3	7	3

Table 5: Number of individuals in each stage of change and progress through the stages (np=55; nb=33; own illustration)

Physical activity level: Everyday, sport and total activity have increased significantly in both groups at the end of the program. 49.1% of the PG and 42.4% of the BG have reached the recommended minimal activity level of 15 total activity points (Figure 3). There is no significant difference between the test groups (p>0,2).

Perception: The PHM was well received by the participants. On average, the participants felt well taken care of, liked using the system, found it easy to use, and have gained knowledge about physical activity and health. They felt healthier and more active (Table 6). The statements “I feel healthier” and “I have become more active” are strongly correlated (p<0.01). Moreover, “I feel healthier” is weakly correlated with functional capacity (p<0.05). Surprisingly, neither of the two is significantly correlated with the increased scores of the physical activity questionnaire. There is no significant difference between the test groups (p>0,2).

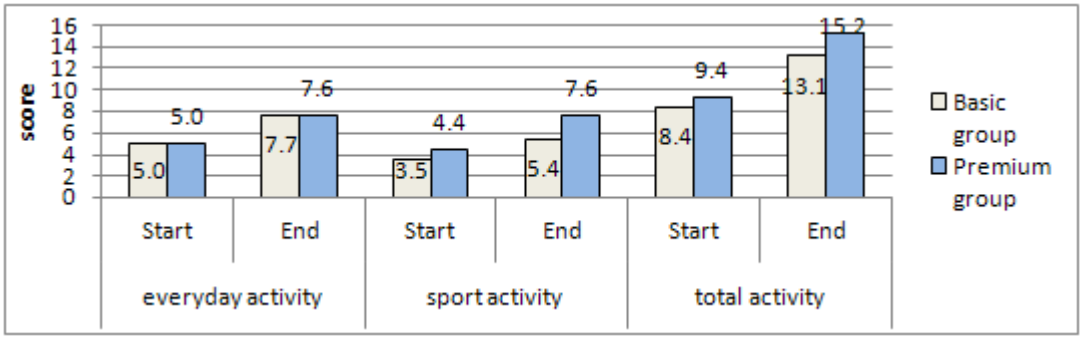

Figure 3: Physical activity level (np=55, nb=33; own illustration)

Statement (5=strongly agree, 1= do not agree at all)	Premium group	Basic group
I have become more active.	4.05	4.18
I have gained knowledge about physical activity and health.	4.22	4.15
I feel healthier.	4.02	3.82
I like using the PHM system.	3.98	3.76
Using the PHM system is easy for me.	4.09	4.24
I was well taken care of and supervised.	4.16	3.85

Table 6: Participants' perception of the PHM program (np=55, nb=33; own illustration)

6 DISCUSSION

6.1 Summary and contributions

In this paper we have presented the design and empirical test of an IT-based physical activity programme, the PHM. Apart from face-to-face contacts in the beginning and in the end of the program, supervision was mainly delivered internet-mediated. Our design decisions were motivated by the TTM. This approach has proved to be successful in the pilot test. The PHM increased participants' activity, functional capacity and motivational readiness for change. The supervision via internet was perceived positively, and the participants had the feeling of being well taken care of. However, enhanced active supervision in the activity phase did not produce stronger effects.

Our research has successfully implemented the approach of theory-driven design as proposed by Briggs (Briggs 2006), applying a theory from psychology to the design of an information system. The results are first evidence that internet-mediated supervision can be successful in promoting physical activity and provides a starting point for investigating the role of face-to-face-contact and other forms of supervision in physical activity programs. The multi-method evaluation data allows a comparison of different measurement results and therefore better interpretation. A major advantage is that the PHM allows supervision of and situational reactions to user behavior, but at the same time, the computer-mediated delivery and supervisor support functions allow a fast and efficient supervision and administration. Therefore, practice will find the PHM and similar designs eligible and useful for large-scale corporate or public health programs, providing an alternative to conventional interventions requiring personal presence.

6.2 Limitations and outlook

The duration of our pilot test was only three months, which might be too short to induce long-term behavior change. We are currently conducting a follow-up survey to shed light on the long-term effects. We are aware that self-report measures as we applied among others can always be biased by the participants' intended or unintended false answers. Where possible, we try to validate self-report

data with other measurement methods, e.g. stages of change and functional capacity. The fact that the premium group did not perform better than the basic group might be due to some limitations resulting from the implementation of the study. There might have been a sense of competition between the groups biasing the results. Technical problems at the beginning of the test did not allow the full delivery of all supervision services to all members of the PG in the first month. An analysis of the qualitative interviews we conducted with all participants at the end of the test will reveal insights into this. Another reason might be that the importance of enhanced supervision increases with the duration of the activity phase, and the effect would only be visible in a longer test.

Further research should therefore examine the effectiveness of IT-supported physical interventions over longer periods of time and test different service levels of supervision. In addition to theories on exercise behavior, it should further draw on knowledge from the computer-human-interaction and technology acceptance and refine the intervention design. It is also necessary to inquire on appropriate easy and reliable methods to accurately capture and supervise participants' activity levels.

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